



**QUEEN'S  
UNIVERSITY  
BELFAST**

## **Food caching as observed through use of den boxes by European pine martens (*Martes martes*)**

Twining, J., Birks, J., Martin, J., & Tosh, D. (2018). Food caching as observed through use of den boxes by European pine martens (*Martes martes*). *Mammal Communications*, 4.

**Published in:**  
Mammal Communications

**Document Version:**  
Publisher's PDF, also known as Version of record

**Queen's University Belfast - Research Portal:**  
[Link to publication record in Queen's University Belfast Research Portal](#)

**Publisher rights**  
© 2018 Mammal Communications.  
This work is made available online in accordance with the publisher's policies. Please refer to any applicable terms of use of the publisher

**General rights**  
Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

**Take down policy**  
The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact [openaccess@qub.ac.uk](mailto:openaccess@qub.ac.uk).



# Food caching as observed through use of den boxes by European pine martens (*Martes martes*)



Photograph © David Tosh

Joshua Twining, Johnny Birks, John Martin and David Tosh





# Food caching as observed through use of den boxes by European pine martens (*Martes martes*)

Joshua Twining<sup>\*1</sup>, Johnny Birks<sup>2</sup>, John Martin<sup>3</sup> and David Tosh<sup>4</sup>

## ABSTRACT

Artificial den boxes have been used to supplement denning sites of the European pine marten (*Martes martes*) in Scotland and Northern Ireland where natural arboreal cavities are scarce. Here, information on food caches from annual checks are reported. Pine martens predominantly cached birds, largely juvenile passerines, followed by small mammals and amphibians. This investigation highlights the potential importance of food caching in the species, as well as the ability of artificial den box schemes to explore enigmatic aspects of marten ecology in the future.

## INTRODUCTION

Artificial den boxes are becoming widely recognised as a valuable tool in the conservation and research of numerous species from various taxa including marsupials, bats, hole-nesting birds, predatory birds and arboreal mammals including martens, squirrels and dormice (Solheim, 1984; Lindenmayer *et al.*, 1991; Newton, 1994; Shuttleworth, 1999; Birks *et al.*, 2005; Panchetti *et al.*, 2007; Croose *et al.*, 2016; Davies *et al.*, 2017).

Provision can occur to supplement existing opportunities that might be limited in existing landscapes due to loss of traditional sites during anthropogenic processes (Lindenmayer *et al.*, 1990; Niemela *et al.*, 2005). Natural cavity development is a slow process typically taking >100 years (Birks *et al.*, 2005; Cameron, 2006) with the aid of insects, fungi, fire or cavity excavating birds i.e. the black woodpecker (*Dryocopus martius*) (Adkins, 2006; Fox *et al.*, 2009). Loss, or lack of nesting or denning opportunities, can limit population sizes, density and diversity of cavity reliant species, particularly those that cannot excavate their own (Lindenmayer *et al.*, 1990;

Newton, 1994; Rueegger, 2016). A contemporary solution has been the deployment of artificial den boxes. As well as being vital as a conservation tool, such den boxes can also be utilised to conduct ecological research (Beyer & Goldingay, 2006), specifically they provide a platform to survey and monitor populations (Panchetti *et al.*, 2007; Croose *et al.*, 2016), obtain information on breeding behaviour (Shuttleworth, 1999; Davies *et al.*, 2017), investigate prey choice and other behaviours difficult to observe under natural conditions (Solheim, 1984). One such behaviour is food caching. Food caching, the act of storing food for later consumption (Henry *et al.*, 1990), is an adaptive behaviour that has been observed in a variety of species (Macdonald, 1976; Solheim, 1984). This behaviour is thought to enable species, that rely on prey whose abundance fluctuates throughout the year (Sherry, 1985), to ensure appropriate resources are available during periods of prey scarcity, or increased demand (e.g. rearing young).

<sup>1</sup> School of Biological Sciences, Queen's University, Belfast, MBC, BT9 7AE, Northern Ireland, UK

<sup>2</sup> Swift Ecology Ltd, Fartown Barn, Pensax, Worcester, WR6 6AE, UK

<sup>3</sup> Myotismart Ltd, Horncop Bungalow, Heversham, Milnthorpe, Cumbria LA7 7EB, UK

<sup>4</sup> National Museums of Northern Ireland, Cultra, Hollywood, BT18 0QE, Northern Ireland UK

\*Corresponding Author: [joshuaptwining@gmail.com](mailto:joshuaptwining@gmail.com)

**Key words:** pine marten, den box, denning ecology, food caching, camera traps, mammal ecology, habitat degradation, habitat management.

Twining J. P., Birks, J.D.S., Martin, J.W. & Tosh, D. G. (2018) Food caching as observed through use of den boxes by European pine martens (*Martes martes*). Mammal Communications 4: 1-6, London

The European pine marten (*Martes martes*) is a semi-arboreal predator native to Ireland and Britain whose populations are recovering (Croose *et al.* 2014; O'Mahony *et al.*, 2017). Scarcity of arboreal denning sites has been suggested as a limiting factor to the species distribution and abundance (Brainerd *et al.*, 1995). Therefore, artificial den box schemes have been implemented to supplement above ground resting sites (Croose *et al.*, 2016). Although the species fits the criterion of a "cacher" (Macdonald, 1976) (e.g. solitary hunter, fixed home range), to our knowledge there are no direct observations of food caching in the species (Marchesi & Mermoud 1989; Balharry, 1993; Helldin, 2000; Zalweski *et al.*, 2004; Lynch & McCann, 2007). Scats collected during winter surveys containing bird eggs from Sweden are the only indirect evidence of this behaviour in pine marten (Helldin, 2000). The lack of evidence of this behaviour is likely due to the species' nocturnal activity

patterns and low densities, as opposed to reflecting the true frequency of this behaviour. In sub-optimal habitats, e.g. commercial forestry plantations, low food availability can leave populations vulnerable to decline. Food caching may therefore be key to ensuring survival through cyclical, seasonal or habitat induced reductions in prey abundance.

Evidence from other mustelids indicate caching behaviour typically occurs around den sites (Sleeman, 1989; Henry *et al.*, 1990). Due to the difficulty in locating natural pine marten den sites (e.g. Birks *et al.*, 2005), the use of artificial den boxes for the species (see Messenger *et al.*, 2006), provides an opportunity to observe this under-recorded behaviour. We report here initial observations of caching behaviour from two pine marten den box monitoring schemes and suggest such schemes could provide insight into a variety of behaviours poorly recorded in the species.

## METHODS

The observations reported here were made during monitoring of den box schemes currently running in the Ring of Gullion, Co. Armagh, Northern Ireland and Galloway Forest, south-west Scotland. In both locations, custom built artificial den boxes (55 cm x 51 cm x 24 cm, mass approximately 13 kg (Figure 1, Messenger *et al.*, 2006) were installed into coniferous plantation forests. Forty boxes were installed in Galloway Forest in 2013, and a further 10 were installed in the Ring of Gullion during winter 2016/17. Den boxes were installed at a height of 3 - 4 m on trees at both locations. Box entrances were orientated away from the prevailing wind direction. In both studies a substrate, either locally collected moss or wood shavings were added to the boxes. In Armagh, Bushnell HD Trophy Camera Traps (Model: 119736) were attached to trees opposite den box entrances, allowing remote monitoring of den box occupancy. During annual checks of den boxes from January - June, opportunistic observations were made of pine martens using the den boxes to cache food. Frequency of occurrence (FO%) was calculated for each observation by dividing the sum of a specific food item by the total food items cached, expressed as a percentage (Fedriani & Travaini, 2000).

**Figure 1. Den box installed 3-4 m above ground near Camlough mountain, Northern Ireland, with a camera trap set up adjacent.**



## RESULTS

Seven separate observations of caching behaviour at five different den boxes were made, four from Scotland and three from Northern Ireland. Caches totalled 66 prey items. Three prey groups were found cached; birds ( $n = 53$ , FO% 66.62%); small mammals ( $n=12$ , FO% 33.11%) and anurans ( $n=1$ , FO% 0.26%) (Table 1).

With the exception of a single large cache (Figure 2,  $n = 53$ ), the caches were generally small ( $n = 1 - 6$ ); five caches were discovered during spring and two during winter. The large cache, and a small cache containing a single item were found at natal den sites containing kits,

the other caches were discovered at currently unoccupied boxes. Birds were the most commonly cached prey group ( $n = 53$ ), these were predominantly small song birds including European robins (*Erithacus rubecula*); common chaffinches (*Fringilla coelebs*); Eurasian wrens (*Troglodytes troglodytes*) and various tits (*Paridae* sp.). A single corvid in the form of a hooded crow (*Corvus cornix*), as well as two wood pigeons (*Columba palumbus*) and a Eurasian woodcock (*Scolopax rusticola*) were also found in caches. The majority of birds cached were juveniles ( $n = 50$ ), with only three adult individuals

discovered. Two of the caches were observed to be returned to and removed by the marten, one cache had been removed after a week, the other within a month. Smalls mammals were the second most commonly cached group ( $n = 12$ ), three species were recorded, the most common being the field vole (*Microtus agrestis*),

followed by the wood mouse (*Apodemus sylvaticus*) and the common shrew (*Sorex minutus*) which were equally recorded. All individuals cached were adults. Finally, the rarest cached group were the amphibians with a single adult common frog (*Rana temporaria*).

Table 1. Pine marten caches found at den boxes with dates, locations and prey composition.

Date	Location	Birds	Number of prey items		Total
			Small Mammals	Common Frog	
21/05/2015	Galloway	44	8	1	53
04/02/2017	Ring of Gullion	2	0	0	2
28/04/2017	Ring of Gullion	1	0	0	1
07/05/2017	Galloway	0	2	0	2
13/05/2017	Galloway	5	1	0	6
07/01/2018	Ring of Gullion	1	0	0	1
14/05/2018	Galloway	0	1	0	1

Figure 2. Pine marten cache consisting of 53 items found in spring in coniferous forest in Galloway Forest, Scotland.



DISCUSSION

Our observations demonstrate that European pine martens cache small to medium-sized prey items. Pine martens usually den in sheltered, elevated cavities and it has been difficult, until recently, to observe caching behaviour. With the implementation of den boxes and camera traps we were able to record such behaviours, demonstrating the use of den boxes in exploring enigmatic aspects of their ecology. Pine martens are highly territorial (Zalewski *et al.*, 1995; Zalewski *et al.*, 2004), and two observations are assumed to be of the same individual caching prey items, returning and feeding on them. Interestingly, contrary to previous assumptions on caching, that it serves as a means of storing prey items that display annual cycles to counteract periods of scarcity (Sherry, 1985), these observations demonstrate consumption of prey items following a short duration of storage. This suggests caching can be a shorter-term food storing behaviour than previously thought and may assist an individual’s survival during

periods of high food demand, e.g. raising young. Another interpretation may be that food caching merely serves to remove prey from capture sites. This would provide additional security by allowing the marten to feed away from competitors or predators such as foxes (*Vulpes vulpes*), which may be alerted to the location of the kill. However, it is important to note that den boxes were only checked infrequently, and it is not possible to comment on the frequency of caching, or annual fluctuations in this behaviour. To further our knowledge on the prevalence of food caching a future investigation encompassing all seasons, and a variety of habitat types would be necessary. The deployment of camera traps at all den boxes or caching sites for a year would allow the collection of data on the duration of time items are cached for and the frequency of visits to the site, as well as reducing the survey effort making it easier to collect such data. It is noteworthy that 53 out of 66 prey items cached were



birds, predominantly Passeriformes. The presence of birds in pine marten diet is typically represented by peaks in occurrence during spring and summer. It has been assumed this was due to the presence of vulnerable juveniles and fledglings in the nest (Lynch & McCann, 2007). However, dietary investigations based on scats fail to provide data on age of individuals consumed; so, this novel approach based on assessing caches allows us to confirm that juveniles and fledglings appear to be targeted in spring and summer. The presence of fledgling rather than adult birds is indicative of an above ground foraging ecology, and the raiding of nests. In consensus with studies on pine marten diet throughout their natural range, passerines make up the bulk of all avifauna predated (Marchesi & Mermod 1989; Balharry 1993; Zalewski *et al.*, 1995; Helldin, 2000; Lynch & McCann, 2007). Despite the fact that in Scotland it has been reported that field voles are the chief prey item for the European pine marten, and occur in 80% of scats (Balharry, 1993), they form only a relatively small fraction of prey items cached in this study. It is important to note that Ireland has a lower small mammal biodiversity compared to Scotland with an absence of native voles (Montgomery *et al.*, 2014). Despite the expected differences in diet (Balharry, 1993; Lynch & McCann, 2007), passerine birds remain the most commonly

cached item at both locations. However, it may not be the complete range of prey items, with the possibility of large, heavy items being stored in ground level caches prohibiting our ability to record such events using this methodology.

This work highlights the value of artificial den box schemes beyond improving our knowledge of caching behaviour in pine martens. The use of den boxes provides potential for novel discoveries in otherwise cryptic aspects of their ecology such as; reproduction, breeding success, developmental growth and survival rates. Therefore, the benefits of such schemes should be evident in a situation where the species range is expanding and whose ecology we need to understand better to reduce potential for conflict in the future. In the case of the latter, provision of artificial den boxes to mitigate for the lack of above ground denning sites in immature or degraded forests, potentially releases pine marten populations from factors that otherwise limit their populations. Reduced predation risk (Brainerd *et al.*, 1995; Birks *et al.*, 2005) and decreased energy costs associated with thermoregulation from use of below ground sites (e.g. burrows and tree roots; Croose *et al.*, 2016), may increase populations. As such, any benefits from providing den boxes should be evaluated based on their ability to increase or decrease conflict in the future.

## ACKNOWLEDGEMENTS

Thank you to Therese Hamill from Newry Mourne and Down District Council for her assistance with the work in the Ring of Gullion and to the Northern Ireland Forest Service for allowing us access to their land for the work.

We would like to thank Prof John Gurnell for invaluable feedback and comments helping us to improve the manuscript.

## REFERENCES

- Adkins, M. F. (2006) A burning issue: using fire to accelerate tree hollow formation in *Eucalyptus* species. *Australian Forestry* 69: 107–113.
- Balharry, D. (1993) *Factors affecting the distribution and population density of Pine Martens (Martes martes) in Scotland*. A thesis submitted for the degree of Ph.D at the University of Aberdeen, Scotland.
- Beyer, G. L. & Goldingay, R. L. (2006) The value of nest boxes in the research and management of Australian hollow using arboreal marsupials. *Wildlife Research* 33: 161–174.
- Birks J.D.S., Messenger J.E. & Halliwell E.C. (2005) Diversity of den sites used by pine martens *Martes martes*: a response to the scarcity of arboreal cavities? *Mammal Review* 35: 313–320.
- Brainerd, S.M., Helldin, J.O., Lindström, E.R., Rolstad, E., Rolstad, J. & Storch, I. (1995) Pine marten (*Martes martes*) selection of resting and denning sites in Scandinavian managed forests. *Annales Zoologici Fennici* 32: 151–157.
- Cameron, M. (2006) Nesting habitat of the glossy black-cockatoo in central New South Wales. *Biological Conservation* 127: 402–410.
- Croose, E., Birks, J.D.S., Schofield, H.W. & O'Reilly, C. (2014) Distribution of the pine marten (*Martes martes*) in southern Scotland in 2013. *Scottish Natural Heritage Commissioned Report No. 740*.
- Croose, E., Birks, J.D.S. & Martin, J. (2016) Den boxes as a tool for pine marten *Martes martes* conservation and population monitoring in a commercial forest in Scotland. *Conservation Evidence* 13: 57 - 61.
- Davies, E.A., Barrientos, R. & Sanz, J.J. (2017) The role of nest-box density and replacement on occupation rates and breeding performance: a case study with Eurasian Blue Tits. *Ornis Fennica* 94: 21 - 32.
- Fedriani, J.M. & Travaini, A. (2000) Predator trophic guild assignment: the importance of the method of diet quantification. *Revue d'Écologie* 55: 129 – 139.
- Fox, J.C., Hamilton, F. & Occhipinti, S. (2009) Tree hollow incidence in Victorian state forests. *Australian Forestry* 72: 39–48.
- Helldin, J.O. (2000) Seasonal diet of pine marten *Martes martes* in southern boreal Sweden. *Acta Theriologica* 45 (3): 409 - 420.
- Henry, S.E., Raphael, M.G. & Ruggiero, L.R. (1990) Food caching and handling by marten. *Great Basin Naturalist* 50(4): 16

Lindenmayer, D. B., Cunningham, R. B., Tanton, M. T. & Smith, A. P. (1990) The conservation of arboreal marsupials in the montane ash forests of the central highlands of Victoria, south-east Australia. II. The loss of trees with hollows and its implications for the conservation of Leadbeater's possum, *Gymnobelideus leadbeateri* (Marsupialia: Petauridae). *Biological Conservation* 54: 133–145.

Lindenmayer, D. B., Tanton, M. T. & Cunningham, R. B. (1991) A critique of the use of nest boxes for the conservation of Leadbeater's possum, *Gymnobelideus leadbeateri*. *Wildlife Research* 18: 619–624.

Lynch, A.B. & McCann, Y. (2007) The diet of the pine marten (*Martes martes*) in Killarney National Park. *Biology & Environment Proceedings of the Royal Irish Academy* 107(2): 67–76.

Macdonald, D. W. (1976) Food caching by red foxes and some other carnivores. *Journal of Tierpsychologie* 42: 170–185.

Marchesi, P. & Mermod, C. (1989) Regime alimentaires de la martre (*Martes martes*) dans le Jura suisse. *Revue Suisse de Zoologie* 96: 127–46.

Messenger J.E., Birks J.D.S. & Braithwaite T. (2006) An artificial natal den box for pine martens (*Martes martes*). Pages 89–98 in: M. Santos-Reis, J.D.S. Birks, E.C. O'Doherty & G. Proulx (eds.) *Martes in Carnivore Communities: Proceedings of the Fourth International Martes Symposium*. Alpha Wildlife Publications, Canada.

Montgomery, W. I., Provan, J., McCabe, B.M. & Yalden, D.W. (2014) Origin of British and Irish Mammals: Disparate post-glacial colonisation and species introductions. *Quaternary Science Reviews* 98: 144 - 165.

Niemela, J., Young, J., Alard, D., Askasibar, M., Henle, K., Johnson, R., Kurttila, M., Larsson, T., Matouch, S. & Nowicki, P. (2005). Identifying, managing and monitoring conflicts between forest biodiversity conservation and other human interests in Europe. *Forest Policy and Economics* 7: 877–890.

Newton, I. (1994) The role of nest sites in limiting the numbers of hole-nesting birds: a review. *Biological Conservation* 70: 265–276.

O'Mahony, D.T., Powell, C., Power, J., Hanniffy, R., Marnell, F., Turner, P. & O'Reilly, C. (2017) Non-invasively determined multi-site variation in pine marten *Martes martes* density, a recovering carnivore in Europe. *European Journal of Wildlife Research*. DOI: 10.1007/S10344-017-1108-3.

Panchetti, F., Sorace, A., Amori, G. & Carpaneto, G.M. (2007) Nest site preference of common dormouse (*Muscardinus avellanarius*) in two different habitat types of Central Italy. *Italian Journal of Zoology* 74: 363 - 369.

Ruegger, N. (2016) Bat boxes- a review of their use and application past, present and future. *Acta Chiropterologica* 18(1): 279 - 299.

Sherry, D.F. (1985) Food storage in birds and mammals. *Advances in the Study of Behaviour* 15:153–188

Shuttleworth, C.M. (1999) The use of nest boxes by the Red Squirrel *Sciurus vulgaris* in a coniferous habitat. *Mammal Review* 29: 61 - 66.

Sleeman, P. (1989) Stoats and weasels, polecats and martens. *British Natural History Series*. 128pp.

Solheim, R. (1984) Caching behaviour, prey choice and surplus killing by Pygmy owls. *Annales Zoologici Fennici* 21 (3): 301 - 308.

Zalewski, A., Jedrzejewski, W. & Jedrzejewska, B. (1995) Pine marten home ranges, numbers and predation on vertebrates in a deciduous forest (Bialowieza National Park, Poland). *Annales Zoologici Fennici* 32: 131 - 144.

Zalewski, A., Jedrzejewski, W. & Jedrzejewska, B. (2004) Mobility and home range use by pine martens (*Martes martes*) in a Polish primeval forest. *Ecoscience* 11 (1): 113 - 122.

